



High Energy Physics Division  
Electronics Support Group

HEP Planning Group  
Dec. 2, 2003

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**Argonne National Laboratory  
High Energy Physics Division  
Electronics Support Group**

**Long Range Planning Presentation**

**Current Projects, Capabilities,  
and New Initiatives**

*Presented By*

*Gary Drake  
Dec. 2, 2003*



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# Group Personnel

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- **Gary Drake** Group Leader, EE
- **John Dawson** Senior EE (part-time)
- **Bill Haberichter** Engineering Specialist
- **Tim Cundiff** Engineering Assistant
- **Leon Reed** Engineering Assistant (part-time)
- **Carolyn Adams** Technician



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# Group Specialties and Expertise

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## A. Design of High-Speed Data Processors

- **Types of Projects:**

- ◆ Trigger Processors
- ◆ Communication Interface
- ◆ Data Acquisition



- **Implementation Techniques:**

- ◆ Multi-Layer Printed Circuit Board Design
- ◆ Programmable Logic Devices (PLD)
- ◆ Field Programmable Gate Arrays (FPGA)
- ◆ Surface Mount Technology
- ◆ Ball Grid Arrays (BGA)



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# Group Specialties and Expertise

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## B. Front End Design

- **Types of Projects:**
  - ◆ Charge Amplifiers
  - ◆ Preamplifiers
  - ◆ Digitizers
  - ◆ Discriminators
  - ◆ Implementation of Custom Circuits (ASICs)
  - ◆ Noise Measurement, Analysis, & Abatement
  - ◆ HV Power Supply Design
- **Implementation Techniques:**
  - ◆ Printed Circuit Board Design
  - ◆ Surface Mount Technology
  - ◆ Custom Circuit Design (with FNAL)
  - ◆ Bare Die or Chip on Board (COB)





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# Group Specialties and Expertise

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## C. System Design

- **Types of Projects:**

- ◆ Trigger Systems (CDF, ATLAS, ZEUS)
- ◆ Front End System for Shower Max (CDF)
- ◆ Front End System for Calorimetry (MINOS, LC)
- ◆ Front End System for Tracking (ZEUS)

» **Often, These Projects Are Leadership Roles...**



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# Current & Recent Projects

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## A. CDF Shower Max Front End Electronics - Run II

- **Activities & Status**

- ◆ Project Engineer

- Responsible for Design of Overall System
- Coordination of Engineering Activities, ANL & FNAL

- ◆ Sub-component Design and Production

- *SMXR* (VME Read-Out Board) - 100 Boards
- *SQUID* (Host PCB for Front-End Custom ASIC) - 5000 Boards
- *Preamp* for Strip & Wire Chambers - 12,000 SIPs

- ◆ Status

- Completed Production in Spring 2001 ►► *Working Well to Date*
- Currently Providing Maintenance & Support for Entire System



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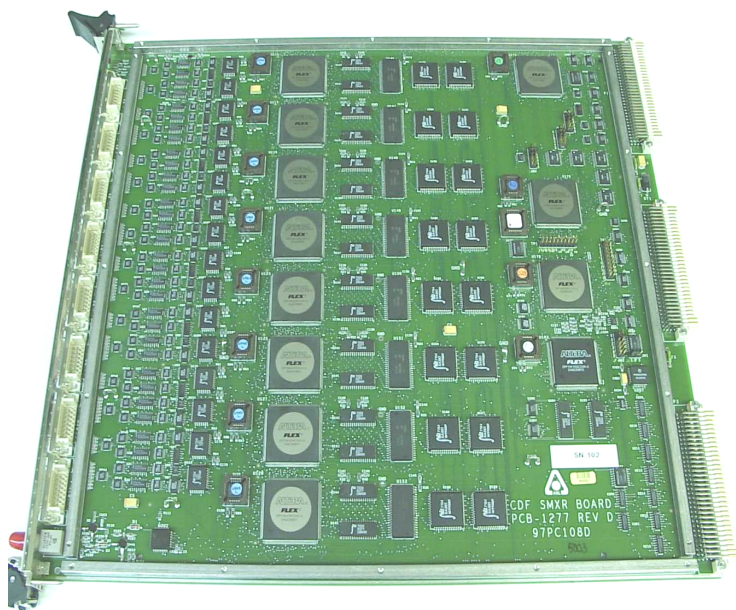
# Current & Recent Projects

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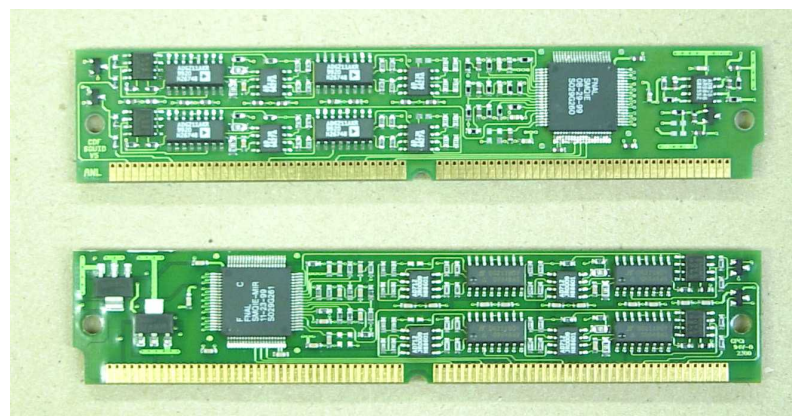
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## A. CDF Shower Max Front End Electronics (Cont.)

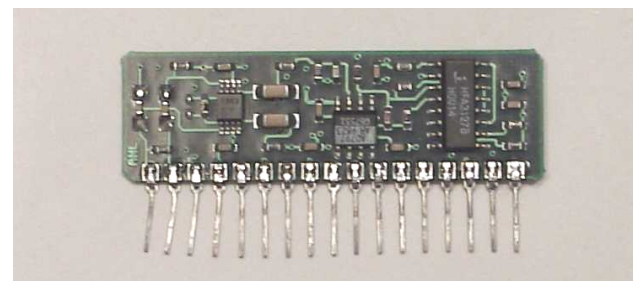
### • Gallery of Our Designs



◆ SMXR



◆ SQUID



◆ CES Preamp



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# Current & Recent Projects

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## A. CDF Trigger Electronics – Run II

- **Activities & Status**

- ◆ *Isolation Trigger*

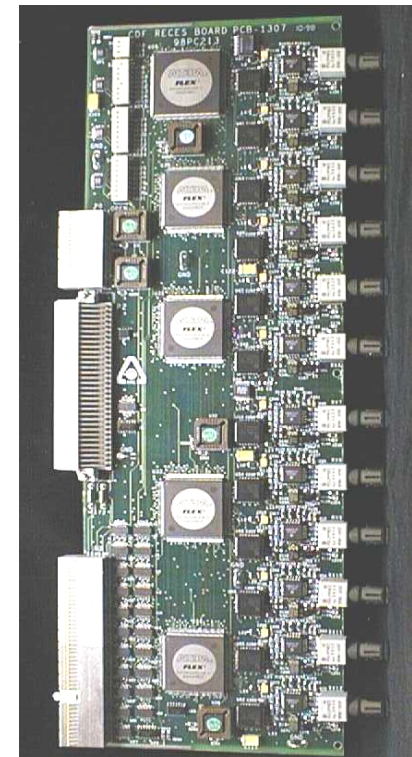
- Level 2 Trigger for Isolated Photons

- ◆ *RECES*

- Level 2 Trigger for Shower Max

- ◆ *Status*

- Completed Production in Spring 2001
- Currently Providing Maintenance & Support



RECES Board



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# Current & Recent Projects

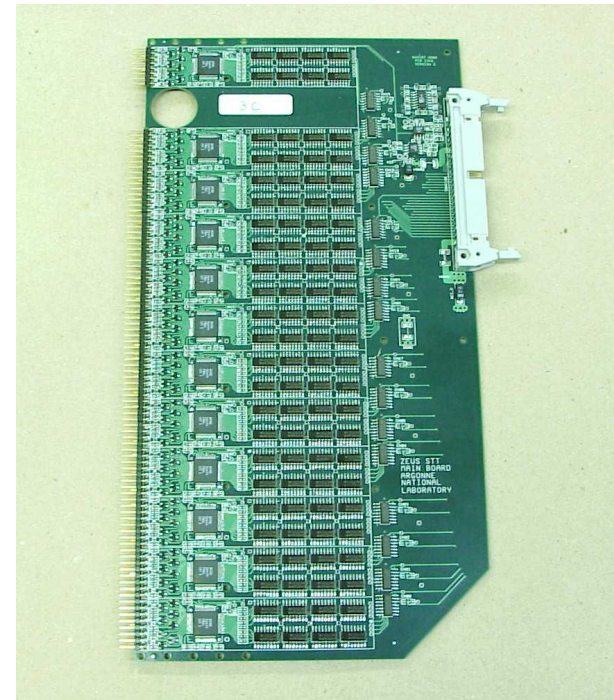
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## C. ZEUS Straw Tube Tracker (STT) Electronics

### • Design and Production of the *Main Board*

- ◆ Discriminator Board for Processing Straw Tube Signals
- ◆ Front End Board Hosts the *ASDQ*, A Custom Front End Chip Designed at PENN
- ◆ Low-Noise, High Sensitivity (2 fC)
- ◆ 150 Boards for Production
- ◆ Status: Completed Spring, 2001



» **High Density Layout, Low Noise Performance,  
Mixed Analog/Digital Circuitry**



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# Current & Recent Projects

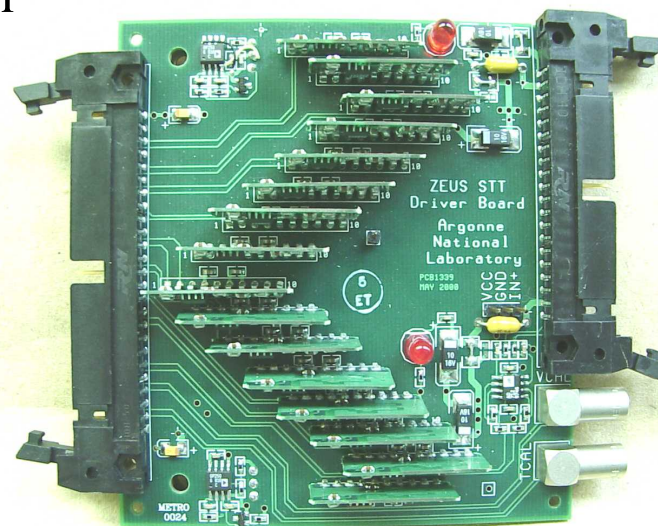
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## C. ZEUS Straw Tube Tracker Electronics (Cont.)

- **Design of the *Driver Board***

- ◆ Board for Driving Discriminated Signals  
~42 M from Detector to Counting Room
- ◆ Contains 16 Driver Amplifiers  
Configured as SIPs
- ◆ Compensates for Lossy Cable
- ◆ 150 Boards for Production
- ◆ Designed at ANL
- ◆ Production and Checkout Done at  
Tel Aviv Univ.
- ◆ Status: Production Completed  
Spring, 2001



» **Novel Amplifier for Compensating Lossy Cable**



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# Current & Recent Projects

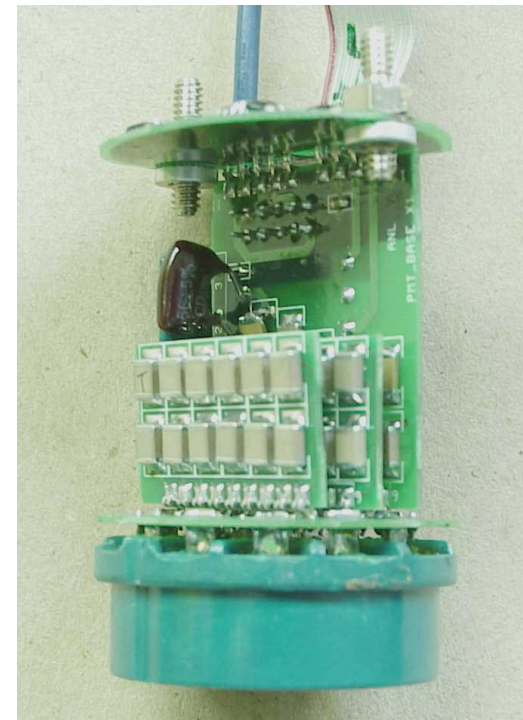
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## D. ZEUS Cockroft-Walton Photomultiplier Base

### • Design and Production of the *CW PMT Base*

- ◆ PMT Base with Internal High Voltage Generation from Low Voltage DC
- ◆ Low Power, Low-Noise, with Monitor Read Back
- ◆ Replacement for Existing Failing Bases
- ◆ 500 (1000) Boards for Production
- ◆ Designed at ANL
- ◆ Production and Checkout Done at Penn State Univ.
- ◆ Status: Production of 500 Completed in Spring, 2001 ► *Working Well to Date*



» **Low Noise, High Density, Unique Packaging, Reliability**



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# Current & Recent Projects

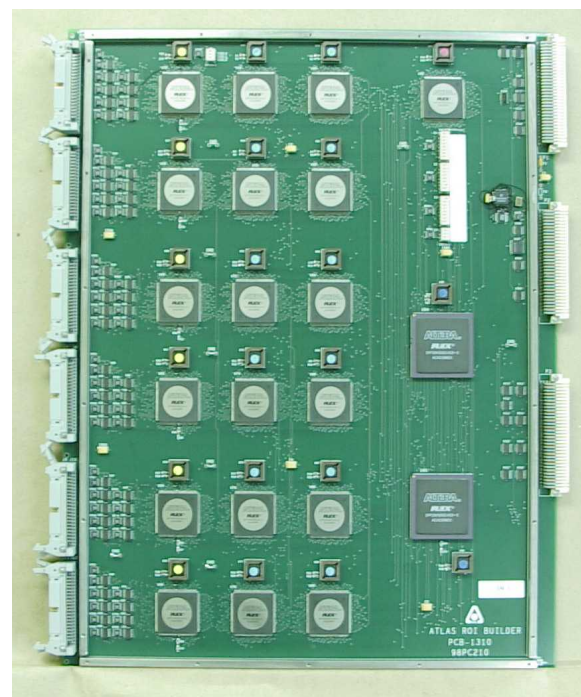
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## E. ATLAS Level 2 Trigger

### • Design of the *Region of Interest (ROI) Builder*

- ◆ Receives Information from Level 1 Trigger, Forms a “Record,” and Passes it to the Trigger Supervisor for L2 Processing
- ◆ High Speed, High Bandwidth, High Density
- ◆ Have Demonstrated Ability to Meet 100 KHz Maximum Output Trigger Rate
- ◆ Status: 1st Prototype Built, & Tested at CERN; Design of Final Prototype in Progress
- ◆ Schedule: Production ~2004



» Extensive Use of High Density Programmable Logic



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# Current & Recent Projects

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## F. ATLAS Communication Link

### • Design of the *TTC Mezzanine Card*

- ◆ Hosts TTCrx Custom Chip, Developed at CERN
- ◆ Timing and Control Information from Master Clock (TTC), Transmitted over Fiber to All Parts of Detector
- ◆ High Speed, High Bandwidth, High Density
- ◆ Uses Ball Grid Array (BGA) Technology
- ◆ Status: 4 Prototypes Tested in ATLAS Tilecal Testbeam; Other Testing in Progress
- ◆ Schedule: Evaluation in Progress...



» High Density Programmable Logic, BGA Packaging



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# Current & Recent Projects

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## G. ATLAS Communication Link

### • Design of the *Gigabit Ethernet Link-Source Card*

- ◆ Receives “S-Link” Input Data Streams
- ◆ Buffers Data, & Re-Transmits over Gigabit Ethernet Fiber
- ◆ Interface Between L1 & L2 Trigger Systems
- ◆ High Speed, High Bandwidth, High Density
- ◆ Status: Prototypes Built;  
Testing in Progress at CERN
- ◆ Schedule: Production ~2004



» Extensive Use of High Density Programmable Logic,  
Complex Functionality



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# Current & Recent Projects

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## H. MINOS Near Detector Front End System

- **Level 3 Manager for Near Detector Electronics**
  - ◆ Responsible for Design of Overall System
  - ◆ Coordination of Subproject Engineering Activities
  - ◆ Design & Production Joint Effort with  
ANL, FNAL, & IIT



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# Current & Recent Projects

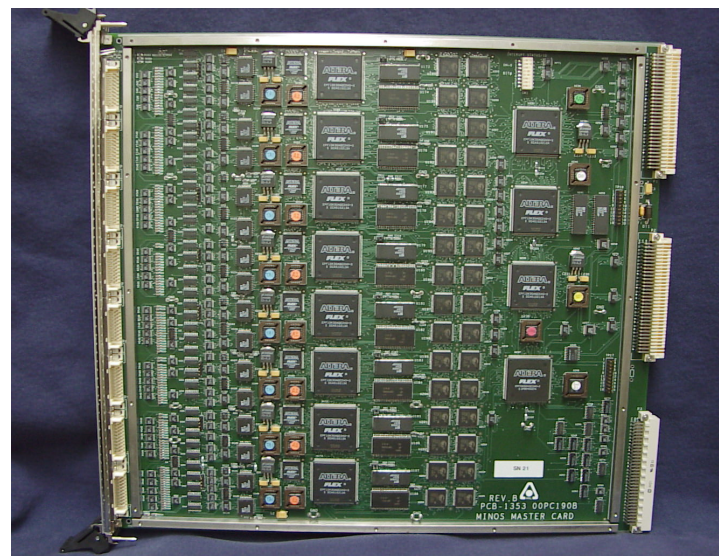
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## H. MINOS Near Detector Front End System (Cont.)

- **Design and Production of the *MASTER Module***

- ◆ High-Speed Front End Data Processor
- ◆ 9U x 400mm VME Board
- ◆ 100 Boards for Production
- ◆ Checkout Performed at ANL
- ◆ Status: Production in Progress
- ◆ Schedule: Complete January 2004



» **Extensive Use of High Density Programmable Logic, Complex Functionality**



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# Current & Recent Projects

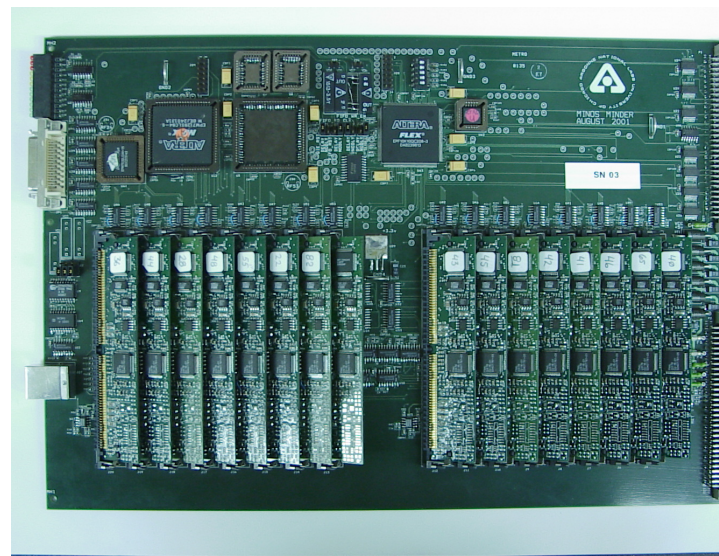
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## H. MINOS Near Detector Front End System (Cont.)

- **Design and Production of the *MINDER* Module**

- ◆ Motherboard for Front End Electronics Channels
- ◆ Host to Daughter Boards Containing *QIEs*, A Custom Front End Chip Designed at FNAL
- ◆ 6U x 340mm VME Board
- ◆ 700 Boards for Production
- ◆ Checkout Performed at ANL
- ◆ Status: Production in Progress



» **High Density Programmable Logic,  
Mixed Analog/Digital Processing, Low Noise**



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# Current & Recent Projects

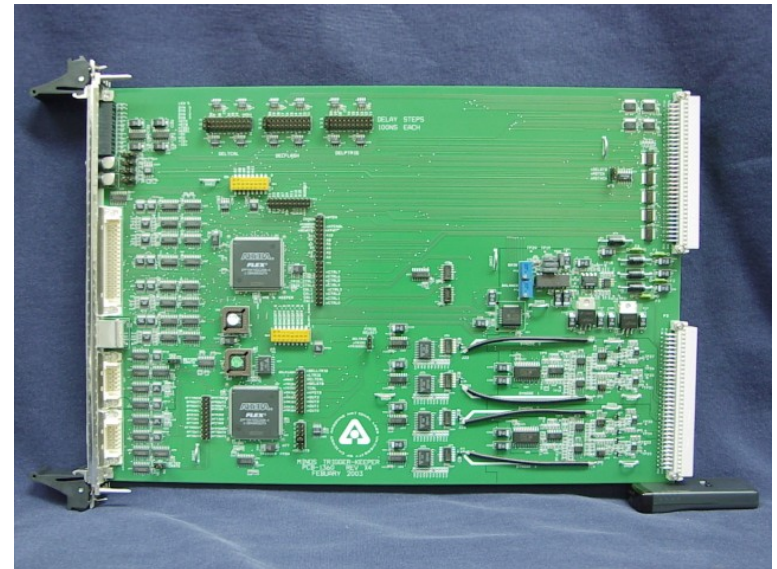
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## H. MINOS Near Detector Front End System (Cont.)

- **Design and Production of the *KEEPER* Module**

- ◆ Controller for Front End Crates
- ◆ Contains Discriminators for PMT Dynodes for Triggering
- ◆ 6U x 340mm VME Board
- ◆ 55 Boards for Production
- ◆ Checkout Performed at ANL
- ◆ Status: Production in Progress
- ◆ Schedule: Complete



» **High Density Programmable Logic,  
Mixed Analog/Digital Processing, Low Noise**



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# New Projects (With Funding)

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## A. Linear Collider

- **Readout System for Hadron Calorimeter**
  - ◆ Detector Technology: Resistive Plate Chambers
  - ◆ Project: Design Readout System for Prototype Detector
    - Overall Front-End Electronics & DAQ
    - Specification of Custom Integrated Circuit (Design at FNAL)
    - Coordination of Design Activities
    - Prototype Design, Development, & Testing
    - Cockroft-Walton HV
  - ◆ Design & Production Joint Effort with  
ANL, FNAL, U of C, & Boston University



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# New Projects (With Funding)

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## B. NUMI Off-Axis Experiment

- **Readout System for Calorimeter**
  - ◆ Detector Technology: Resistive Plate Chambers (Scintillator?)
  - ◆ Project: Design Readout System for Detector
    - Overall Front-End Electronics & DAQ
    - Specification of Custom Integrated Circuit (Same as LC...)
    - Coordination of Design Activities
    - Prototype Design, Development, & Testing
    - Cockroft-Walton HV
  - ◆ Design & Production Joint Effort with ANL & FNAL (and LC...)



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# New Projects (With Funding)

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## C. Veritas

- **Readout System for Upgraded Telescope**
  - ◆ Detector Technology: Mult-Anode PMTs
  - ◆ Project: Design Readout System for Prototype Detector
    - Evaluation of MAPMTs for Telescope
    - Overall Front-End Electronics & DAQ
    - Prototype Design, Development & Testing
    - Trigger System?



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# Future Projects

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- **Projects We Are Discussing:**

- Front End Electronics for *OMNIS*
- L2 Upgrade for *CDF Run IIB*
- Front End Electronics for *Reactor Neutrino Experiment*



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Expertise By Discipline	System Design	Digital Design	Prog. Logic Design	Analog Design	Ana/Dig PCB Design	Ground, Shield, & Noise	FE Pwr System Design	Custom IC Design	Checkout, Building, Testing	Comp. Program Support
Dawson (Engineer)	★	★	★				★			
Drake (Engineer)	★			★	★	★	★	★		
Cundiff (Eng. Asst.)					★				★	
Haberichter (Eng. Spec.)		★	★						★	
Reed (Eng. Asst.)									★	
Adams (Tech)	Support								★	



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# Manpower Projection

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- **FY2004:**

- Support of **CDF & MINOS**
- Development of ROI Builder & Peripherals for **ATLAS**
- R&D for (Funded) **LC, Veritas, & NUMI Off-Axis**

» **Sufficient Work for Entire Group + Programmer**

- **FY2005:**

- Support of **CDF & MINOS**
- Production of ROI Builder for **ATLAS** (?)
- Production of Electronics for **LC Testbeam**
- Continued R&D for **Veritas, & NUMI Off-Axis** (Funding?)

» **Sufficient Work for Entire Group**



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# Manpower Projection

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- **Beyond FY2005:**

- Support of **CDF & MINOS**
- Support of ROI Builder for **ATLAS**
- **LC:** *What's Next?*
- **Veritas & NUMI Off-Axis:** *Do They Take Off?*

» **Staffing Requirements Dependent on New Initiatives**



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# Summary

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- **We Are Supporting:**

- **CDF** Shower Max Electronics
- **CDF** Trigger Electronics
- **ZEUS** STT Electronics
- **ZEUS** CW PMT Base

- **Current Active Projects:**

- Production of **MINOS** ND Front End Electronics
- Development of **ATLAS** ROI Builder
- Development of **ATLAS** TTC Mezzanine Card & LSC

- **New Active Projects:**

- **Linear Collider** HCAL
- **NUMI Off-Axis** FEE
- **VERITAS** FEE

- **Future Projects:**

- **OMNIS** FEE
- **CDF** Run IIB L2 Trigger
- **Reactor Neutrino** FEE